

Accelerated Modern Erosion In Las Vegas Wash, Clark County, Nevada

BUCKINGHAM, S.E. and WHITNEY, J.W., U.S. Geological Survey, Federal Center, MS 980, Denver, CO 80225; GLANCY, P.A., USGS, 333 W. Nye Lane, Carson City, NV 89706; and EHRENBERG, A., Southern Nevada Water Authority, 1001 S. Valley View Blvd., Las Vegas, NV 89153

Chronology Of Modern Erosion

its valley floor during the late 19th and early 20th Century.

vegetation attenuated the high flows and promoted sediment deposition.

Las Vegas Wash was a typical desert ephemeral stream characterized by a sparse growth of desert shrubs on

Wastewater effluent to the lower wash began during the mid-1900's, as a result of a growing population in the

• Increasing moisture progressively changed desert-shrub vegetation to a lush greenbelt with marshlands. During

floods, most of the runoff and sediment load spread across the flood plain, because the dense greenbelt

• Wastewater releases saturated the floodplain of LLVW during the early 1950's; thereafter, seasonal (winter)

Flood-plain aggradation by sluggish, sediment-charged floods began to give way to the growing influence of

accommodate increasing annual streamflow. The first visual evidence of degradation by baseflow was subtle

• In early July 1975 a major flood (peak flow >1000 ft³/s) heavily eroded several reaches of the destabilized

headcuts were significantly enlarged. Thus incision into and erosion of the floodplain began to accelerate.

• Nine years after the July 1975 episode, eight major floods during only six weeks in the El Niño summer of

wash. Although floodwaters added a final layer of fine-grained sediment to the vegetated floodplain, existing

1984 dramatically transformed LLVW by integrating all of the remaining, discontinuous channel reaches. The

seven following storm runoffs further streamlined the newly integrated fluvial thoroughfare, transforming it

• After the integration of the discontinuous channels in 1984, increasing wastewater discharge and annual

• In 2000 a consortium of government agencies initiates channel stabilization projects in lower Las Vegas Wash.

(Summarized from Glancy, P.A. and Whitney, J.W., in press, Fluvial evolution of Lower Las Vegas Wash,

southern Nevada, through 1989--Urban growth triggers channel erosion: U.S. Geological Survey Scientific

These engineering projects will stabilize the wash by controlling further erosion and reclaiming wetlands on the

increasingly frequent storm-generated floods of generally increasing magnitudes.

floods continued to both deepen and especially widen the 1984 integrated channel.

into an efficient floodway that was further deepened and widened in response to a growing baseflow and the

channelization of short, narrow flood-plain reaches; this channelization subsequently initiated several headcuts

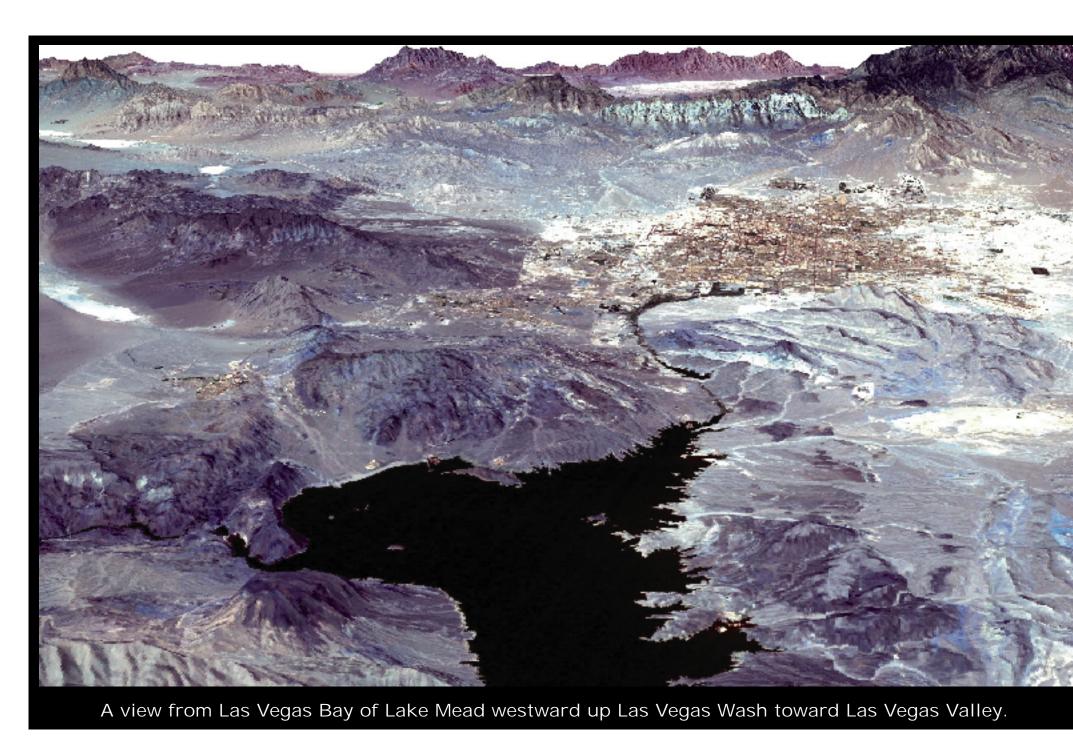
clear wastewater baseflow. The growing discharge of sediment-lean baseflow expanded the channel to

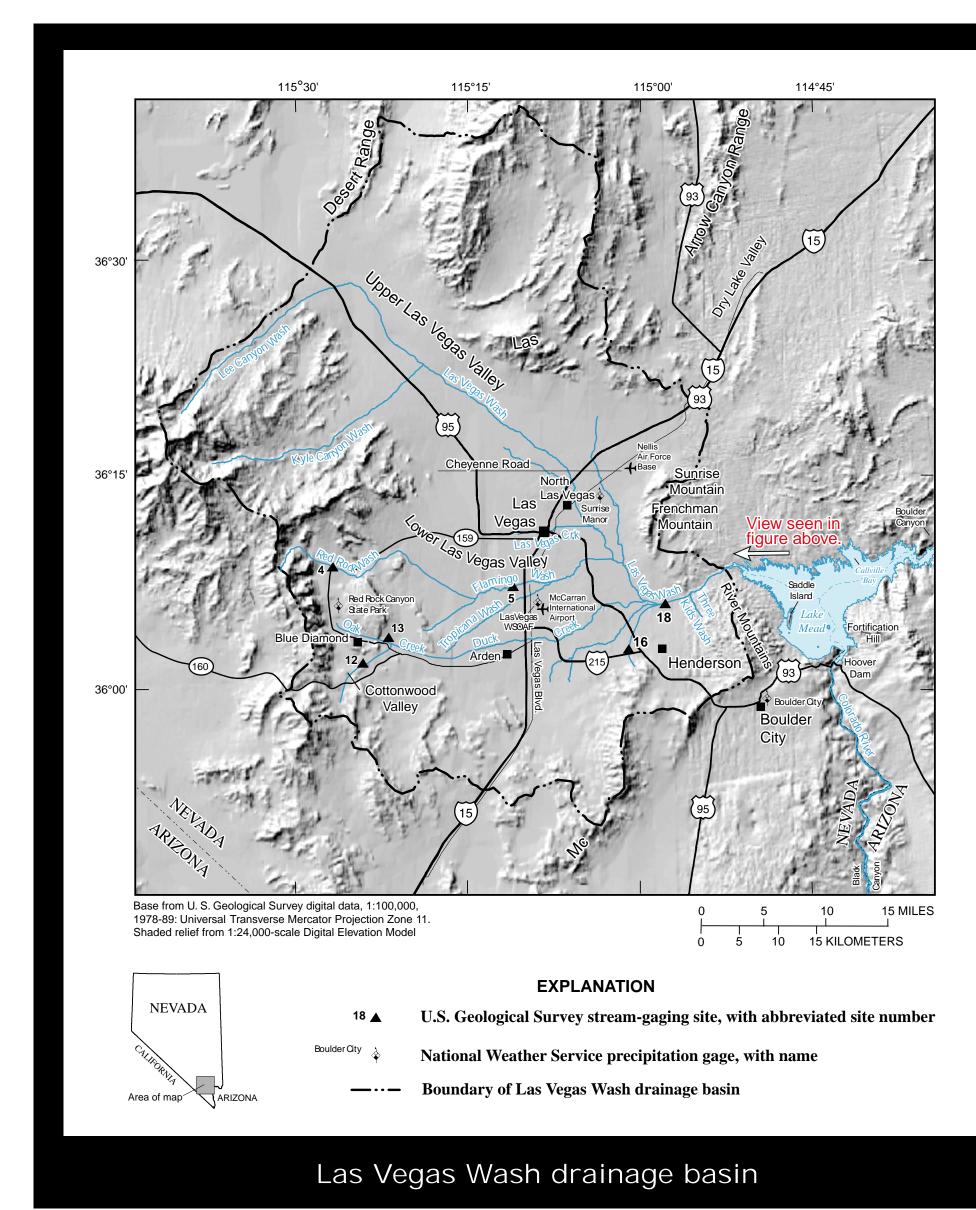
baseflow began. Perennial streamflow at the mouth of the wash was first observed in 1955.

valley. Wastewater entered LLVW as ground-water flow and surface discharge and gradually saturated the

ABSTRACT

The second half of the 20th century saw the unprecedented population growth of Las Vegas Valley from about 127,000 in 1960 to over 1.6M in 2003. Urban growth drastically changed the surface hydrology across the valley and resulted in steadily increasing wastewater runoff though Lower Las Vegas Wash to Lake Mead. During the 1950s-60's the initial wastewater releases created broad wetlands on the valley floor; however, continually increasing sediment-free wastewater resulted in several discontinuous headcuts by the late 1960s. By 1984 these headcuts integrated into a deep channel during a series of El Niñogenerated storms. Aerial photosets of Lower Las Vegas Wash from 1975, 1989, and 1999 were digitized and rectified to characterize modern channel changes and eroded sediment volumes. Volume calculations are based on DEMs and channel reconstructions where no DEMs exist. Average channel widths increased from 8 feet in 1975 to about 120 feet in 1999. The amount of sediment eroded from the time of initial valley inhabitation to 1975 was approximately 135,000 cubic yards. From 1975 to 1999 more than 65 times that amount of sediment was eroded from the wash into Las Vegas Bay of Lake Mead. The majority of the sediment was removed from 1984-1989, which indicates that once the wash was destabilized through the loss of vegetation and incision, storm events were able to accelerate erosion by continued channel downcutting and widening. Between 1989 and 1999, continued urban growth resulted in increased storm runoff that further eroded channel walls. The changes in channel dimensions and erosion destroyed wetlands, valley bottom property, and local roads. In addition, reconstruction of a bridge and the valley's main water supply pipeline were also required. Since 2000, state and local agencies have worked together to implement a comprehensive engineering and management plan, at a cost of several tens of millions of dollars, to stabilize the channel and enhance the wetland ecosystem.





Introduction

The Las Vegas urban area is situated about 2,000 ft above sea level in Las Vegas Valley, a dominantly arid to semi-arid topographic basin in the southern Basin and Range Province—a region characterized by rugged, individual mountain ranges separated by wide valleys (basins) with low

Las Vegas Wash was an ephemeral drainage in 1900. It sustained flow only during and immediately after intense rainstorms, and it was directly tributary to the Colorado River. One hundred years later, the wash discharges into Lake Mead at Las Vegas Bay, and is perennial from its mouth to a point at least 12 mi upstream from the bay. In 1958—the first full calendar year of stream gaging on the wash—the average outflow was only 21 ft³/s and water imports from Lake Mead averaged 25 ft³/s. During 1989, ground-water withdrawals in Las Vegas Valley totaled about 64,400 acre-ft, whereas imported lake water totaled about 243,600 acre-ft. Outflow from the valley by way of Las Vegas Wash during that same calendar year averaged about 166 ft³/s. During

calendar year 2000 flow near the mouth averaged 222 ft³/s and consisted mostly of treated municipal sewage effluent. The increasing flow in Las Vegas Wash has greatly altered the hydrologic character of that drainage. Initially, the most visible alteration was a change in riparian vegetation, including increases in species and densities. This change was followed by erosion of the flood plain of lower Las Vegas Wash as the channel system evolved to accommodate the increasing

Lower Las Vegas Wash was transformed from an ephemeral wash to a stream with annually increasing streamflow as a result of the unprecedented population growth in Las Vegas Valley. From 1970 to 2000 the population increased over five-fold from 273,000 to more than 1.5 million residents. An important component of that growth, particularly since mid-century, has been the influx of tourists and other visitors. Between the start of this study in 1975 and 1989, the number of visitors per year almost doubled, from 9.2 million to 18.1 million. Urban growth was not only responsible for increasing wastewater discharge, but also changed the infiltration and rainfall runoff patterns in the valley, which in turn, has affected flooding in the valley and in lower Las Vegas Wash.

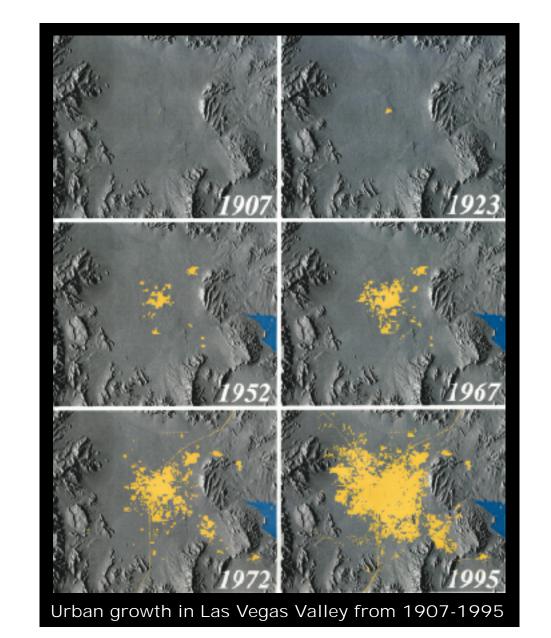
> Population (calendar year) Streamflow (water year)

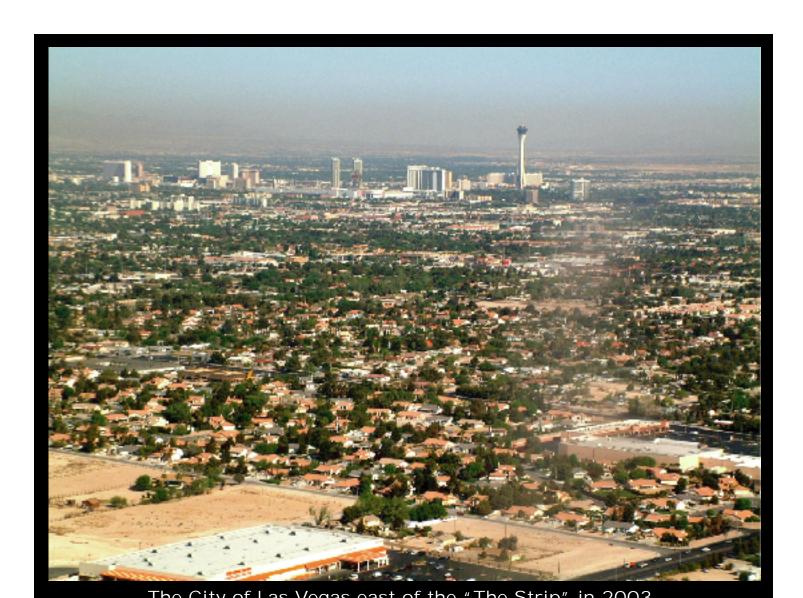
910 1920 1930 1940 1950 1960 1970 1980 199

Population growth in Las Vegas Valley, 1910-1989,

Wash at the Henderson stream gage.

pared with increasing streamflow in Lower Las Vega





The City of Las Vegas east of the "The Strip" in 2003.

Methodology Used for Erosion Calculations

Three sets of aerial photos of Las Vegas Wash from 1975, 1989, and 1999 were scanned and registered in GIS format. On the 1999 and 1989 photosets, the active channel and areas adjacent to the channel that had undergone physical changes were digitally mapped.

The 1975 channel volume was calculated based on headcuts visible in the photoset along with field measurements and historical documents that characterize channel depths.

We calculated the sediment removed between 1975-1989 and 1989-1999 by using a DEM to calculate the channel geometry and fitting a lid to each 3D polygon by using elevations just outside of channel boundaries. Channel geometries were converted into raster files that represent the former channel surface and the deeper, incised channel floor as portrayed on the airphotos. Volume calculations are based on the differences of those elevations and the mapped channel areas. We used two different DEMs for each calculation so that internal errors within the DEMs are excluded and our calculations capture the magnitude of sediment removal.

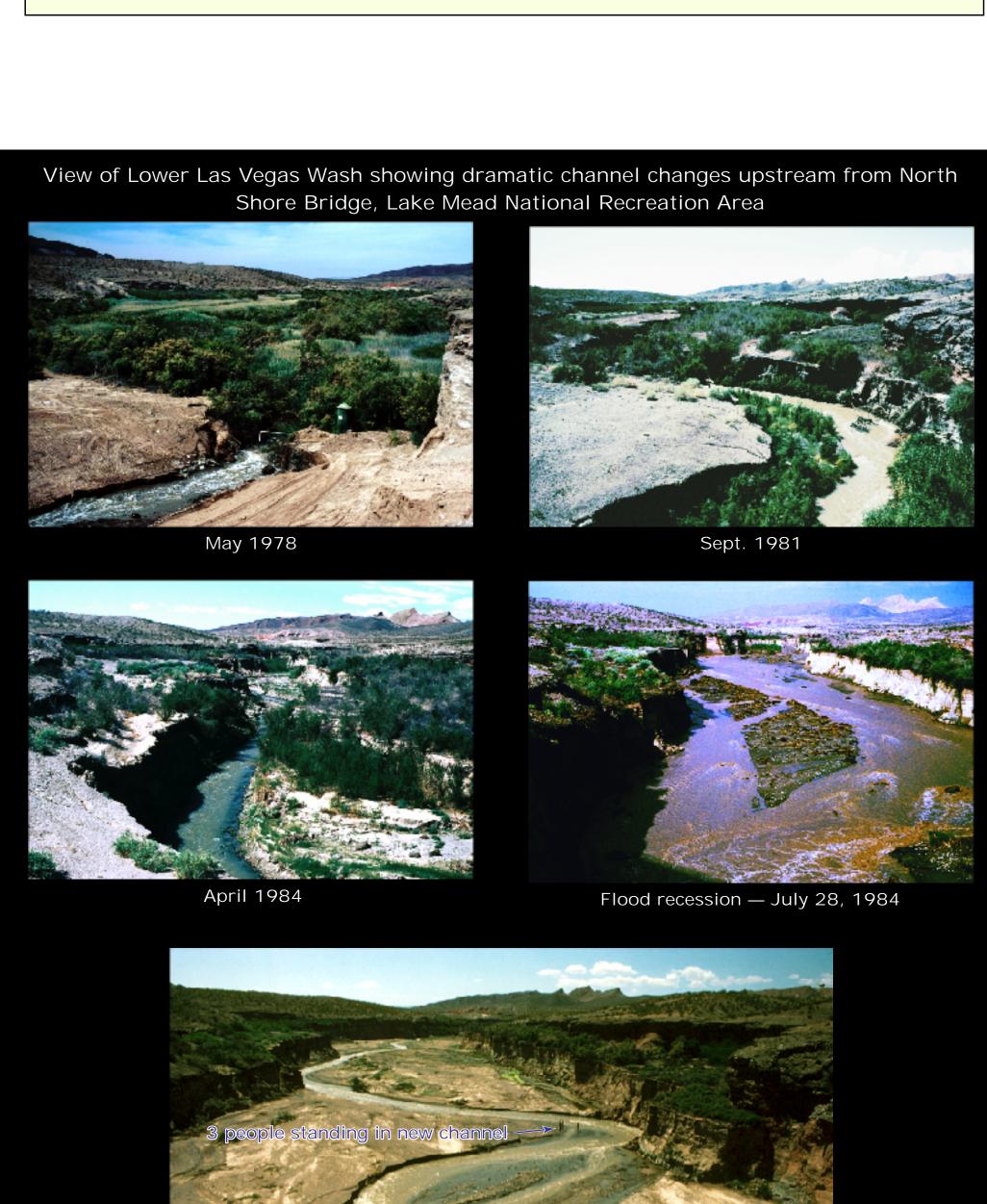
The 1999 DEM was created by traditional engineering practices using large-scale airphotos and ground surveying. The 1989 DEM was created using a set of orthophotos from 1989/90. Two small sections of the wash were missing from our 1989 DEM. We used information from the 1989 DEM, 1999 DEM, and contour information from the 1977 topographic map in order to contour these small areas. This information was then included in our 1989 DEM.

The people listed below have been helpful in solving the many GIS roadblocks that have popped up along the way during this study:

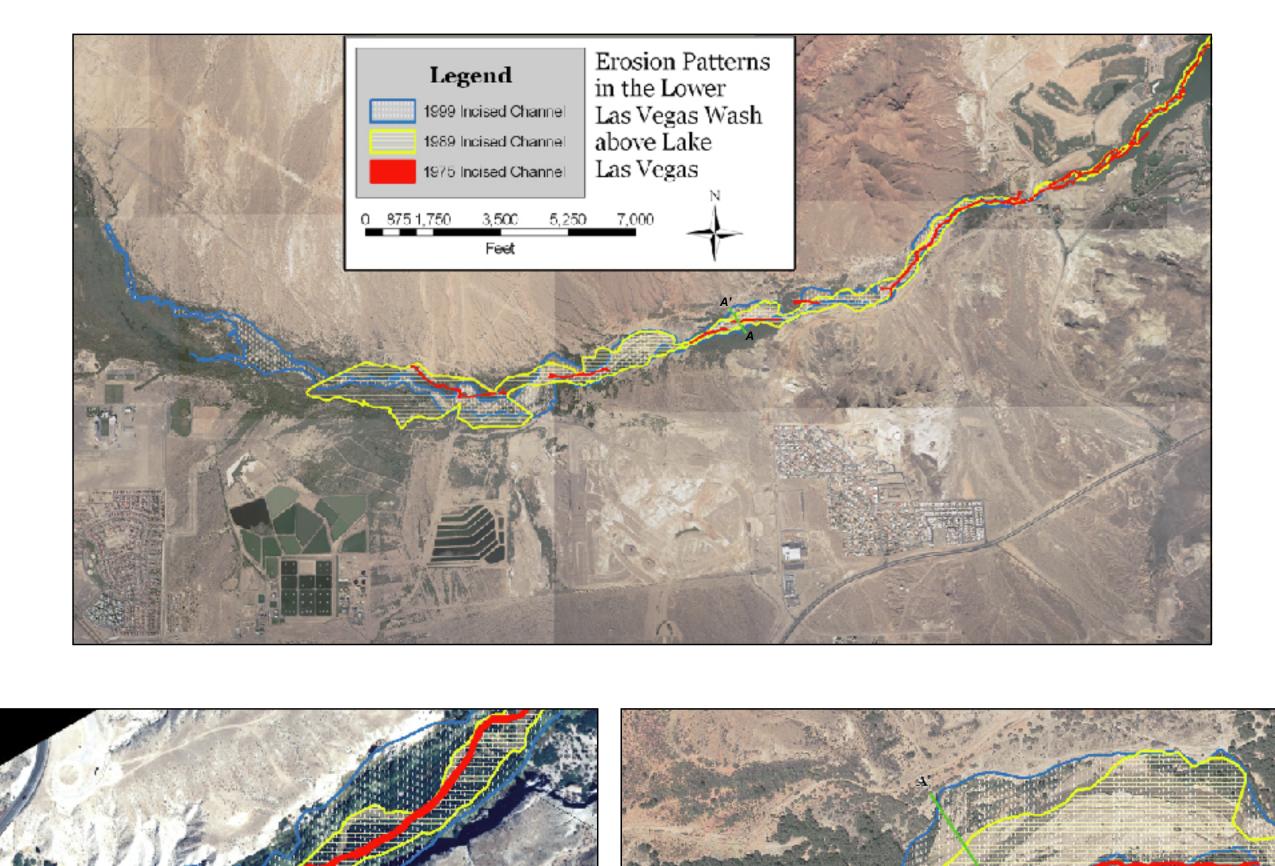
VeeAnn A. Cross (USGS) Curtis Price (USGS) Paco Van Sistine (USGS) Joseph J. Kerski (USGS)

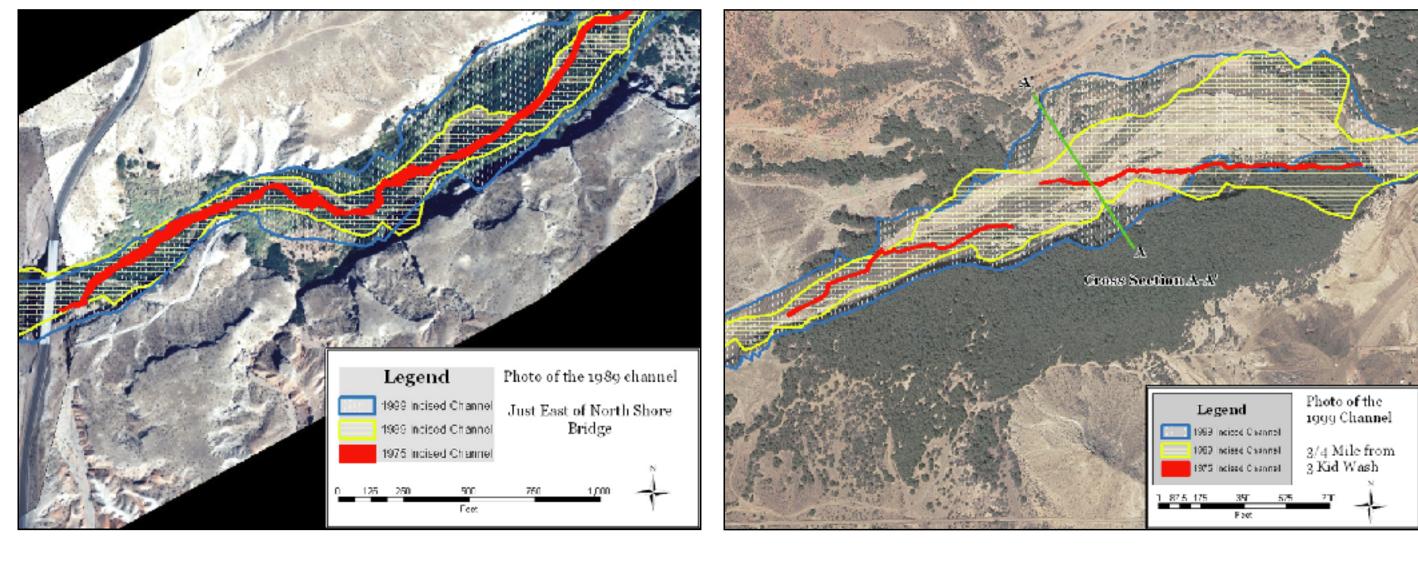
Paul Townsend (City of Las Vegas) Greg McDermott (City of Las Vegas) Marc Rivera (Bechtel Nevada/Remote Sensing Lab)



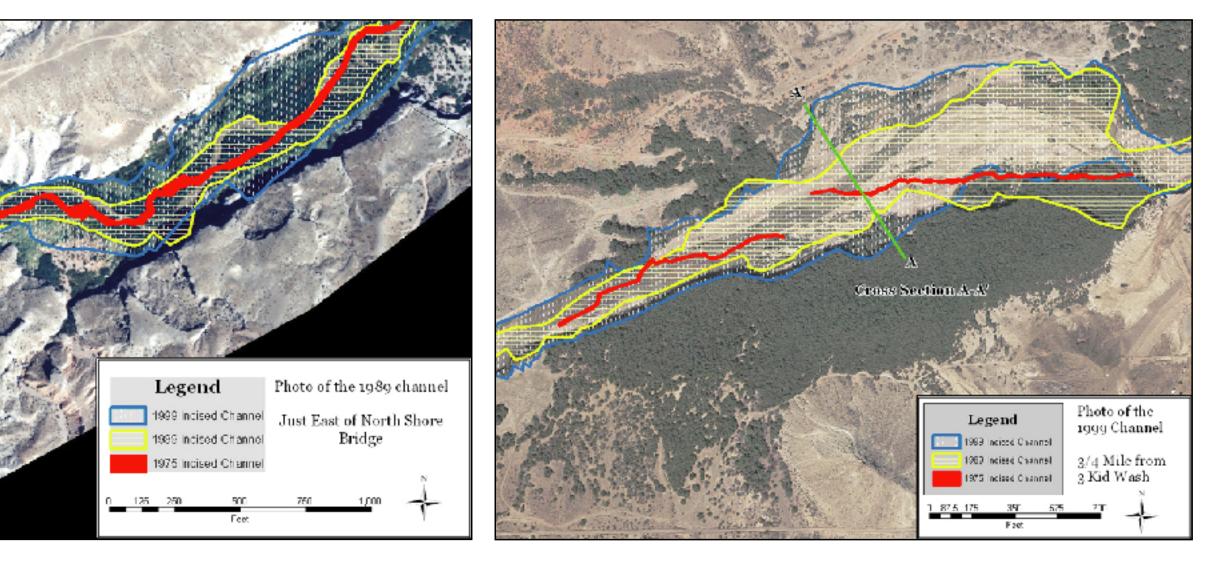


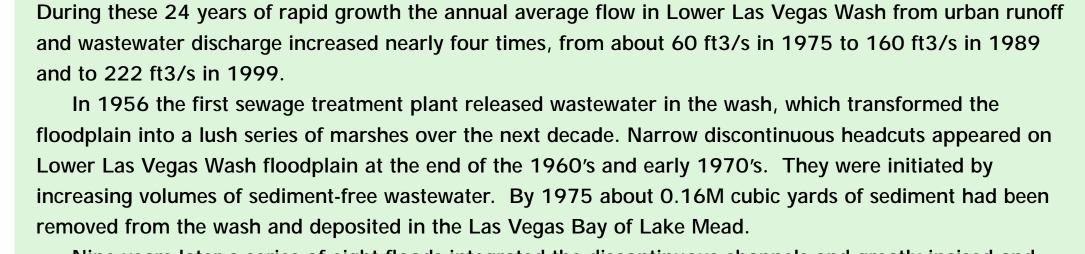
April 1985





Calculation of Modern Erosion in Las Vegas Wash





an about 273,000 to approximately 747,000 people. By 2000 the population was over 1.4 million.

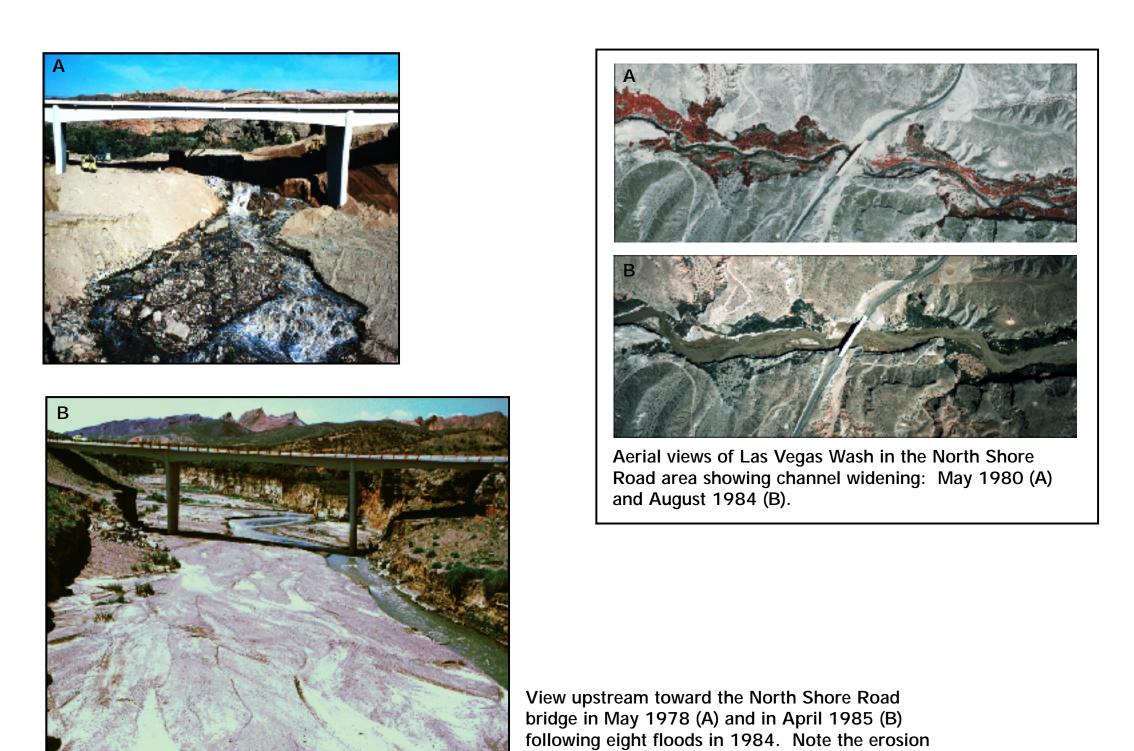
DISCUSSION

Nine years later a series of eight floods integrated the discontinuous channels and greatly incised and widened the channel. By 1989 nearly 4.5M cubic yards of sediment were eroded from the wash and created a growing delta in the upper part of Las Vegas Bay.

From 1975 through 1989 the population of Las Vegas Valley (Clark County) more than doubled, from

Erosive stripping of alluvial fill in LLVW continued through 1999 in proportion to an increasing baseflow and amplified by floods. Progressive channel incision and meandering in soft silty sand alluvium caused further deepening and widening throughout the 7-mile reach. During the last 10 years before major engineering interventions were initiated, another 4M cubic yards of sediment was added to the delta in Lake Mead. The delta has grown to such a length that Las Vegas Bay is no longer the main marina and boat dock for Lake Mead. The facility has been moved closer to Hoover Dam.

Other major damage from the erosional degradation of LLVW included the replacement of a culvert road crossing with an expensive bridge; the multimillion-dollar re-burial of a 90-inch water-supply pipeline deeper beneath the downcutting wash; and the destruction of a greenbelt wildlife refuge by channel incision and expansion. Less obvious but long-lasting consequences include the contamination of Las Vegas Bay in Lake Mead with eroded debris, and the establishment of a lower base level for drainages tributary to LLVW that will promote upstream migration of erosion within those sub-basins. Along with \$87-99M of ongoing and planned engineering structures to stabilize the wash, the erosion of Lower Las Vegas Wash (8.6M cubic yards in 15 years) may well be the costliest example of environmental degradation directly attributable to



below original fill line surrounding bridge struts



